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Report No. UT-17.13

REDUCING PROJECT DELAYS AND COSTS DUE TO UTILITY RELOCATIONS

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16. Abstract

A study was conducted to evaluate the costs incurred in Utah Department of Transportation's projects due to utility relocations. Projects starting after November 14, 2012 and closed out by October 31, 2016 were evaluated resulting in a total of 415 projects. The data included 396 design-bid-build projects, 13 CM/GC projects, 4 design-build projects, and 2 other projects (which were emergency repair projects). Out of the 415 projects, 99 of them had utilities. Out of those with utility cost overruns, the average percentage overrun was 22.9%. A random sample of 10 projects that had utilities and were over budget was selected for further analysis and compared to a random sample of projects that were under budget and a random sample of projects with no utilities. The analysis resulted in recommendations for changes including consistency in data collection. Specific accounting changes are discussed in the report.

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LIST OF ACRONYMS

CM/GC	Construction Manager/General Contractor
CPI	Cost Performance Index
DB	Design Build
DBB	Design Bid Build
ePM	Electronic Program Management
FHWA	Federal Highway Administration
PDBS	Project Development Business System
UCOFN	Utility Contract Overrun Funding Need
UDOT	Utah Department of Transportation

EXECUTIVE SUMMARY

This study was conducted to evaluate the costs incurred in Utah Department of Transportation's (UDOT's) projects due to utility relocations. All projects starting after November 14, 2012 and closed out by October 31, 2016 were evaluated resulting in a total of 415 projects. The data included 396 design-bid-build projects, 13 CM/GC projects, 4 design-build projects, and 2 other projects (which were emergency repair projects). Out of the 415 projects, 99 of them had utilities. Out of those with utility cost overruns, the average percentage overrun was 22.9%. A random sample of 10 projects that had utilities and were over budget was selected for further analysis and compared to a random sample of projects that were under budget and a random sample of projects with no utilities. The analysis resulted in the following recommendations for changes including consistency in data collection:

- The accounting system should be set up to track utility budgets at (1) programing, (2) beginning of design, and (3) prior to construction and after the majority of the utility agreements have been signed; and procedures for preparing these budgets should be established.
- Procedures should be established as to the level of detail required from utilities for estimates used in preparing the utility agreements.
- Separate line items in the accounting system should be set up for (1) utility relocation and (2) providing power to traffic signals, lighting, and signage so that they may be tracked separately.
- A Utility Agreement Log should be set up to track project, date of agreement, utility, amount, status, close out status, and notes for each utility agreement.
- Procedures should be established to ensure that all of the utility costs incurred by the general contractor are captured by the accounting system and charge against the utility relocation budget.
- Procedures should be established for closing out the utilities, collecting all of the related documentation, and documenting missing documentation.
- Procedures for documenting delays should be reviewed, and where needed, improved.

- Where possible, entering data in two different systems should be avoided, either by combining systems or having the systems share or exchange data.
- The utility relocation budget line item should be set up so that (1) the total utility relocation costs and (2) the utility relocation costs by utility can be easily obtained from the system.

UDOT is currently upgrading their construction accounting system. Many of the above changes can be incorporated into this upgrade with little or no cost, as well as some of the training.

1.0 INTRODUCTION

1.1 Problem Statement

Delays in relocating utilities can have a big impact on a highway transportation project's schedule and costs. This research project was funded in an effort to better understand where utility delays are occurring and develop a method to measure the cost and performance of utility relocations.

1.2 Objectives

The primary objective of this research project is to review UDOT's cost database to determine:

1. The expected percentage (and range) of the project's budget being spent on utility relocations. This data is to be analyzed by project/program/portfolio type (e.g. pavement preservation, reconstruct/widening, new alignments, signals), by project delivery method (DBB, DB, CM/GC), and type of utility (electric, gas, communications).
2. Review historic change order documentation to estimate the cost changes due primarily to utility relocation work. This data is to be analyzed using the same breakdowns as in Objective 1.
3. Develop a recommendation on data tracking requirements that would be practical for UDOT to implement for measuring future program performance of utility relocation. Detail how this data would be collected in UDOT's project delivery process and what changes UDOT would need to make; and estimate the implementation costs.

1.3 Scope

This report only looked at utility costs incurred by third-party contractors (e.g., communication, gas, power, and railroad) and not utility work that is typically performed by the general contractor (e.g., water, sewer, and storm drain), the reason being that work performed by the general contractor is tracked separately from utility relocation costs.

This work is based on the data available in three different UDOT databases:

- Project Development Business System, PDBS, is used for estimating, bidding, civil rights, administration, accounting, documenting, and reporting for construction projects.
- ePM is an Electronic Program Management system that tracks projects, funding, budgeting, contracting, and management data.
- ProjectWise is a Bentley Systems document management system for key project files.

The report includes an evaluation of all UDOT projects started after November 14, 2012 and closed out by October 31, 2016. Projects that were started after November 14, 2012, but had not been closed out were not included in the data set because their data is incomplete and would bias the analysis of the data. This resulted in a total of 415 projects. The data included 396 design-bid-build projects, 13 CM/GC projects, 4 design-build projects, and 2 other projects (which were emergency repair projects). To account for different types of work, each of the projects were classified into one of the 14 project descriptions shown in Table 1 based on their primary project description. Projects that fit into more than one description were placed in the description that accounted for the largest amount of work.

Table 1 Project Descriptions

Number	Description
1	Traffic management systems (ATMS), signalization, and lighting where the primary work is electrical in nature
2	Bridge, deck, or other structure, including new, repair, and preservation
3	Capacity improvement including road widening
4	Drainage improvement and maintenance
5	Emergency repair
6	Intersection and interchange improvements
7	Major rehabilitation of roadways
8	Minor rehabilitation of roadways
9	New construction
10	Preservation of roadway
11	Railway highway grade crossing
12	Roadside improvements include trails, fencing, bike paths, landscaping, walls, wildlife
13	Safety improvement including barriers
14	Other/Unknown

1.4 Outline of Report

This report consists of the following sections.

- Introduction
- Data Analysis
- Sampling Methodology
- Project Review
- Recommendations
- Appendices

2.0 DATA ANALYSIS

2.1 Overview

This chapter provides a description of the data and statistical analysis performed to meet Objective 1: determine the expected percentage (and range) of the project's budget being spent on utility relocations.

2.2 Analysis

This data was analyzed by project type (e.g. pavement preservation, new construction, drainage improvements, etc.), by project delivery method (DBB, DB, CM/GC), and type of utility (electric, gas, communications). A breakdown of the number of projects by delivery method and project description is shown in Table 2.

Table 2 Total Number of Projects in Data Set

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	20	24	26	9	6	13	33	68	11	89	5	37	49	5	395
CM/GC	0	0	2	1	0	1	2	1	4	0	0	2	0	0	13
Design-build	0	0	0	1	0	2	0	0	2	0	0	0	0	0	5
Other	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Total	20	24	28	11	8	16	35	69	17	89	5	39	49	5	415

1. Refer to Table 1

2.3 Descriptive Statistics

Of the 415 projects evaluated, 99 of the projects had utilities. Projects were considered to have utilities if they had a budget for utilities, actual utility costs, or both. A breakdown of the number of projects with utilities by delivery type and project description is shown in Table 3 and the percent of projects with utilities is shown in Table 4.

Table 3 Number of Projects Containing Utilities

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	7	6	14	1	0	9	10	7	9	4	3	4	12	2	88
CM/GC	0	0	1	1	0	1	2	0	2	0	0	0	0	0	7
Design-build	0	0	0	0	0	2	0	0	2	0	0	0	0	0	4
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	7	6	15	2	0	12	12	7	13	4	3	4	12	2	99

1. Refer to Table 1

Table 4 Percent of Projects Containing Utilities

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	35	25	54	10	0	69	30	10	82	4	60	11	24	40	22
CM/GC	-	-	50	100	-	100	100	0	50	-	-	0	-	-	54
Design-build	-	-	-	-	-	100	-	-	100	-	-	-	-	-	100
Other	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0
Total	35	25	54	18	0	75	34	10	76	4	60	10	24	40	24

1. Refer to Table 1

A dash (-) indicates that there were no projects in the category

The number of projects with utility cost overruns is shown in Table 5. A project was considered to have a utility cost overrun if the actual utility costs exceeded the original utility budget by more than one dollar. One dollar was chosen to eliminate rounding errors that occurred on three projects where the budget amount was equal to the actual costs when the actual cost was rounded down to a whole dollar. The percent of projects with utility cost overruns is shown in Table 6 and is expressed as a percentage of the number of projects with utilities (Table 5/Table 3).

Table 5 Number of Projects with Utility Overruns

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	0	2	3	0	-	2	0	3	0	0	0	2	2	1	15
CM/GC	-	-	1	0	-	1	0	-	0	-	-	-	-	-	2
Design-build	-	-	-	-	-	0	-	-	0	-	-	-	-	-	0
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	2	4	0	-	3	0	3	0	0	0	2	2	1	17

1. Refer to Table 1

A dash (-) indicates that there were no projects with utilities in the category.

Table 6 Percent of Projects with Utility Overruns

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	0	33	21	0	-	22	0	43	0	0	0	50	17	50	17
CM/GC	-	-	100	0	-	100	0	-	0	-	-	-	-	-	29
Design-build	-	-	-	-	-	0	-	-	0	-	-	-	-	-	0
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	33	27	0	-	25	0	43	0	0	0	50	17	50	17

1. Refer to Table 1

A dash (-) indicates that there were no projects with utilities in the category.

For the projects with utility cost overruns (the projects in Table 5), the average percentage overrun was 22.9%. The average percentages of the overruns by delivery method and project description are shown in Table 7.

Table 7 Average Percentage of Utility Overruns

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	-	0.3	57.5	-	-	16.6	-	14.1	-	-	-	21.8	33.5	7.9	24.9
CM/GC	-	-	10.9	-	-	13.3	-	-	-	-	-	-	-	-	12.1
Design-build	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	0.3	42.0	-	-	15.5	-	14.1	-	-	-	21.8	33.5	7.9	22.9

1. Refer to Table 1

A dash (-) indicates that there were no projects with utilities overruns in the category.

For projects with utilities (i.e., utility budget, utility costs, or both), the utility budget as a percentage of the original contract bid amount averaged 13.4% with a standard deviation of 54.8%. The percentage ranged from 0% (for those projects that had utility budget but no utility costs) to 440%. The median was 2.8%, which indicates that the curve is skewed towards the smaller percentages.

For design-bid-build projects with utilities, the utility budget as a percentage of the original contract bid amount averaged 14.3% with a standard deviation of 58.0%. The percentage ranged from 0% (for those projects that had utility budget but no utility costs) to 440%. The median was 2.8%, which indicates that the curve is skewed towards the smaller percentages. The average utility original budget as a percentage of the original contract bid amount by delivery method and project description is shown in Table 8.

Table 8 Average Original Utility Budget as a Percentage of the Original Contract Bid Amount

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	7.5	3.0	2.9	1.2	-	6.9	4.2	2.8	3.3	1.5	294.9	0.6	7.7	2.9	14.3
CM/GC	-	-	12.1	0.1	-	0.9	4.3	-	18.8	-	-	-	-	-	8.5
Design-build	-	-	-	-	-	4.7	-	-	0.0	-	-	-	-	-	2.4
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	7.5	3.0	3.5	0.6	-	6.0	4.2	2.8	5.2	1.5	294.9	0.6	7.7	2.9	13.4

1. Refer to Table 1

A dash (-) indicates that there were no projects with utilities in the category.

For projects with utilities, the average actual utility costs as a percentage of the final estimate amount—including change orders, overruns, underruns, LDs, disincentives, incentives, etc.—was 7.3% with a standard deviation of 23.9%. The percentage ranged from 0% to 172%. The median was 1.15%, which indicates that the curve is skewed towards the smaller percentages.

For design-bid-build projects with utilities, the average actual utility costs as a percentage of the final estimate amount was 7.5% with a standard deviation of 25.2%. The percentage ranged from 0% to 172%. The median was 1.2%, which indicates that the curve is skewed towards the smaller percentages.

The average actual utility costs as a percentage of the final estimate amount by delivery method and project description is shown in Table 9.

Table 9 Average Actual Utility Cost as a Percentage of the Final Estimate Amount

	Project Description[1]														
Delivery Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Design-bid-build	5.0	2.4	1.5	1.1	-	5.3	2.5	1.5	2.6	0.8	136.1	0.6	5.2	3.4	7.5
CM/GC	-	-	13.6	0.1	-	1.0	4.1	-	15.1	-	-	-	-	-	7.6
Design-build	-	-	-	-	-	1.9	-	-	0.0	-	-	-	-	-	0.9
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	5.0	2.4	2.3	0.6	-	4.4	2.8	1.5	4.1	0.8	136.1	0.6	5.2	3.4	7.3

1. Refer to Table 1

A dash (-) indicates that there were no projects with utilities in the category.

Based on the large ranges and large standard deviation found when comparing utility costs to the project costs (both budgeted and actual), there is no indication that project costs can be used to predict utility costs with any degree of accuracy.

2.4 Correlation

A correlation test can be used to determine if there is a relationship between two variables. Correlation coefficients range from 1 representing a perfect correlation (both variables move together) to -1 representing a perfect negative correlation (both variables move together but in opposite directions). A correlation coefficient of 0 indicates no correlation.

Correlation tests were run to see if there was a relationship among the utilities going over budget and time and cost expended on the project. The following correlations were investigated:

- The correlation between the percent of the utility budget spent (actual utility costs/original utility budget) and the percent of the duration used (actual number of days used by the contractor/original bid number of days) was -0.0481, which indicates that there is little correlation.
- The correlation between the percent of the utility budget spent (actual utility costs/original utility budget) and the percent of the contract amount spent (final estimate amount/original contract bid amount) was 0.0496, which indicates that there is little correlation.
- The correlation between the utilities going over budget (i.e., the actual utility costs exceeding the original utility budget) and the project's schedule being extended (i.e., the actual number of days used by the contractor exceeding the original bid number of days) was 0.0283, which indicates that there is little correlation.
- The correlation between the utilities going over budget (i.e., the actual utility costs exceeding the original utility budget) and the project's costs increasing (i.e., the final estimate amount exceeding the original contract) was -0.1052, which indicates that there is little correlation.
- The correlation between the original utility budget and the original contract bid amount for the project was 0.4321, which indicates there is a weak correlation.

- The correlation between the actual utility costs and the final estimate amount for the project was 0.3816, which indicates there is a weak correlation.

Based on the correlation analysis, there is no indication that any of the above variables can be used to predict utility costs or utility cost overruns with any degree of accuracy.

2.5 Summary

Based on the data analyzed, it was concluded that project cost or duration could not be used to predict utility costs.

3.0 SAMPLING METHODOLOGY

3.1 Overview

This chapter discusses the sample sizes, sample selection methodology, and identifies the projects that were sampled as part of the documentation review performed to meet Objective 2: review historic change order documentation to estimate the cost changes due primarily to utility relocation work.

3.2 Sample Sizes

During the first phase of this project, 415 projects were identified as starting after November 14, 2012 and closed out by October 31, 2016. The emergency repairs and preservation of roadway project types, which had a low percentage of utility work (0% and 4%, respectively), were removed from the sampling pool. The sample pool was divided into three groups:

i) projects with utilities that were over budget,

ii) projects with utilities that were on or under budget, and

iii) projects without utilities.

Projects were considered to have utilities if they had a utility budget or utility costs. As previously mentioned, projects were considered over budget if the actual utility cost was more than $1 above the utility budget, which was done to avoid identifying projects with rounding issues as being over budget. The number of projects in each of these three groups is shown in Table 10. It was later decided to add a fourth group (Group D), which included four preservation projects with utilities. All of Group D utilities were on or under budget.

Table 10 Project Count

Group	All Projects	Initial Sample Pool
A - Utilities and over budget	17	17
B - Utilities and on/under budget	82	78
C - No utilities	316	223
Total	415	318

In order to obtain an unbiased representation of all projects, the initial sampling pool was separated into the three groups shown in Table 10 plus the preservation group. With the exception of the preservation group (where all of the projects were selected), a random sample was taken from each of the groups. The sample sizes were selected as follows:

- Ideally, all 17 of the projects that had utilities and were over budget would be sampled during the second phase of this project, because there are lessons to be learned from each of these projects. However, based on the available budget for this work, this was not feasible. As such, 10 of these projects were randomly sampled, for a sampling rate of 59%.
- A control group is necessary to increase the validity of the research findings. Having a controlled group is necessary to estimate the number of projects that contain each type of utility and the utility's likeliness of going over budget. The control group for this project was a random sample taken from the projects that had utilities and were on or under budget. As such, eight of these projects were randomly sampled, for a sampling rate of 10%.
- It was suspected that the utility cost identified during the first phase of this project might not be reported. These first two sample groups allow this hypothesis to be tested. It is also presumed that findings regarding the non-reporting of the utilities determined from the first two sample groups also apply to the projects that did not have any utilities; however, there is no way to assess this hypothesis without sampling the projects that did not have any utilities. Moreover, there is no way to estimate the number of projects that include utilities without sampling this group. As such, 12 of these projects were randomly sampled, for a sampling rate of 5%.

3.3 Sampling Methodologies

For a sample to be statistically unbiased, the samples should be randomly selected from the sample groups. Due to the fact that the number of projects constructed using the CM/GC and design-build delivery methods is a small portion of the total number of projects and the recommended samples sizes are small, there is the potential for a random sample to exclude CM/GC and design-build projects, thereby leaving out a key portion of the sample population

and introducing bias into the results. The samples were checked for this potential problem and, if necessary, the samples were stratified into design-bid-build, CM/GC, and design-build groups before selecting the projects to be sampled. The sampling methodology used to select a random sample consists of assigning each project in the group a random number and selecting the projects based on their random number from highest to lowest.

3.3.1 Group A: Utilities and Over Budget

For Group A, ten randomly selected projects that had utilities—where the utility costs exceeded the budgeted utility costs—were examined. The selected projects (shown in Table 11) included eight design-bid-build projects and two CM/GC projects. There were no design-build projects with utility costs that exceeded the budgeted utility costs; therefore, design-build cannot be included in this sample. The project identification number (PIN) is a number assigned by UDOT to each of their projects. The Record ID is a number assigned by the research team to each of the 415 projects in the research data set.

Table 11 Projects Reviewed for Group A

Record ID	PIN	Project Number	Delivery Method
9	7109	F-0087(4)0	Design-bid-build
16	7867	F-R399(85)	Design-bid-build
28	8581	F-LC49(123)	Design-bid-build
40	9413	S-0252(7)0	CM/GC
55	9951	F-I15-2(54)57	CM/GC
67	10004	F-0209(25)7	Design-bid-build
239	11547	F-0193(10)1	Design-bid-build
247	11679	F-0126(27)2	Design-bid-build
386	13023	F-0273(9)2	Design-bid-build
406	13592	F-0089(407)406	Design-bid-build

3.3.2 Group B: Utilities and On or Under Budget

For Group B, eight randomly selected projects that had utilities—where the utility costs did not exceed the budgeted utility costs—were examined. The selected projects (shown in Table 12) included six design-bid-build projects, one design-build project, and one CM/GC project.

Table 12 Projects Reviewed for Group B

Record ID	PIN	Project Number	Delivery Method
24	8112	F-LC35(203)	Design-bid-build
25	8129	F-1978(1)0	Design-bid-build
111	10709	S-0026(22)0	CM/GC
115	10785	S-I15-1(106)8	Design-build
139	10916	F-0040(116)0	Design-bid-build
205	11408	F-0266(63)3	Design-bid-build
294	12181	F-0189(54)3	Design-bid-build
329	12292	F-0203(23)0	Design-bid-build

3.3.3 Group C: No Utilities

For Group C, 12 projects without a utility budget and without utility costs were examined. Initially these projects consisted of 10 design-bid-build projects, one CM/GC project, and one design-build project. During the review, it was determined that the design-build project (PIN 12197) was a design-bid-build project. To preserve the integrity of the random sample, the project was dropped from the sample, because it would not have been selected as a design-bid-build project. Because there were no other design-build projects in the prospective sample pool, the next design-bid-build project (PIN 10875) from the randomly ordered list of projects was added to the review. This resulted in the same projects being sampled as would have been sampled if PIN 12197 had been identified as a design-bid-build project prior to identifying the initial sampling pool. The final list of projects reviewed is shown in Table 13.

Table 13 Projects Reviewed for Group C

Record ID	PIN	Project Number	Delivery Method
73	10034	F-0089(306)328	Design-bid-build
75	10066	F-0040(123)68	Design-bid-build
99	10595	F-I15-1(101)5	Design-bid-build
135	10875	F-0089(327)498	Design-bid-build
166	11235	S-0193(8)0	CM/GC
167	11244	S-0191(108)394	Design-bid-build
193	11381	F-I15-8(153)379	Design-bid-build
197	11385	F-I84-6(120)81	Design-bid-build
292	12176	F-R199(161)	Design-bid-build
357	12485	F-0143(25)12	Design-bid-build
373	12670	F-R499(255)	Design-bid-build
408	13707	S-0092(29)2	Design-bid-build

3.3.4 Group D: Preservation Projects

For Group D, the four preservation projects with utility costs were examined. These projects (shown in Table 14) are all design-bid-build projects.

Table 14 Projects Reviewed for Group D

Record ID	PIN	Project Number	Delivery Method
49	9691	F-0186(23)0	Design-bid-build
101	10634	S-R399(164)	Design-bid-build
315	12241	F-R399(193)	Design-bid-build
332	12311	F-0089(369)307	Design-bid-build

3.4 Summary

The sampling plan used random sampling of stratified groups to collect data of three groups of projects—projects with utilities that were over budget, projects with utilities that were on or under budget, and projects without utilities—constructed using three different delivery methods. Additionally, all preservation projects with utilities were sampled.

4.0 PROJECT REVIEW

4.1 Overview

This chapter discusses utility cost overrun by group, identifies references to utility delays found in the documentation, examines utility overruns by utility class, and provides a summary of the findings from this review.

4.2 Utility Overruns by Group

This section summarizes the utility cost overruns by group. Appendix A contains additional information on the individual cost overruns. When there were multiple agreements with the same utility on the same project, they were treated as a single agreement in this analysis.

4.2.1 Group A: Utilities and Over Budget

For Group A, 10 of 17 utility agreements went over budget. Of these, seven were power agreements (three of which were agreements with city-owned power utilities) and three were communication agreements. The sources of the cost overruns are shown in Table 15. Six anomalies were found while reviewing the documentation for Group A, which are listed in Appendix B.

Table 15 Sources of Cost Overruns

Source	Number of Occurrence
Missing budget for power source	4
Unplanned scope change (other than missing power source)	3
Underestimating costs by utility	1
Excessive design costs or poor design cost control	1
Repairs to utilities damaged during construction	1
Unknown	4

Note: More than one source may be identified with a cost overrun.

4.2.2 Group B: Utilities and On or Under Budget

For Group B, one of 17 utility agreements went over budget. The cause of this overrun is not known. Sixteen anomalies were found while reviewing the documentation for Group B, which are listed in Appendix B.

4.2.3 Group C: No Utilities

No utility costs were found for any of the projects in Group C, nor was there any utility documentation.

4.2.4 Group D: Preservation Projects

Of the four projects in Group D, there were seven utility agreements, five of the agreements were on or under budget and two agreements did not have any utility costs. Five anomalies were found while reviewing the documentation for Group D, which are listed in Appendix B.

4.3 Noted Utility Delays

The documentation was reviewed for specific references to utility delays. No reference to utility delays was found in Groups C and D.

4.3.1 Group A: Utilities and Over Budget

The following utility delays were specifically identified in Group A:

- PIN 7867: Change Order 5 states, "…Twenty-two additional contract days are being added to the contract for utility installation delays by [the gas company]…." No utility agreement was found for the gas company.
- PIN 13023: Change Order 2, which includes an additional fiber box (along with other non-utility work) resulted in a seven-calendar day extension to the contract.

4.3.2 Group B: Utilities and On or Under Budget

The following utility delays were specifically identified in Group B:

- PIN 11408: In a change order, the contract time was increased from 65 to 100 calendar days primarily due to delays caused by the relocation of a communication utility. Originally, the utility relocation was to be completed on August 11, 2015, but was not completed until October 6, 2015. Other utilities, including the power and two other communication utilities, did not complete their work on time. The contractor was also responsible for delays due to lower than expected production rates, rework, and insufficient staffing of the project.
- PIN 12181: A change order documented a delay in getting a power pole of the required length delayed the pouring of a concrete sidewalk, which resulted in additional costs to UDOT for the sidewalk.

4.4 Utility Cost Overruns by Utility Class

Forty-three utility-project combinations were examined to see which class of utility was going over budget. When there were multiple agreements with the same utility on the same project, they were treated as a single agreement in this analysis. Two of the projects in Group B had a utility budget, but did not have any utility costs and none of the projects in Group C had a utility budget or costs. These projects were not included in this analysis. The results of this analysis are shown in Table 16.

Table 16 Over Budget Breakdown

Utility Class	Utilities Over Budget	Total Utilities	Percentage
Communications	3	18	17
Gas	0	4	0
Power	8	14	57
Railroad	0	3	0
Other/Unknown	0	2	0
Total	11	41	27

4.5 Findings and Comments

The documentation review yielded nine key findings. These findings, and recommended ways to address the findings, are discussed next.

4.5.1 Budget Timing

While reviewing the data, it appears that the time the utility relocation budgets were established varies among the projects. For example, on three of the projects (PINs 9691, 9951, and 10709), the total of the utility agreements significantly exceeded (40 percent or more) the project's utility relocation budget. Of these projects, two of the projects' (PINs 9691 and 10709) utility relocation costs were under budget and one (PIN 9951) was over budget. This may indicate that these budgets were established before the utility agreements were signed. On another project (PIN 10785), the total of the utility agreements exceeded the utility relocation budget; however, the actual costs were within $1 of the actual costs. This is an indication that the budget was established after the work was done.

Recommendations: When measuring utility relocation cost performance, it is importation that the budget used in the comparison be established at a consistent point in the project's life cycle, such that the expected accuracy of the budget is as consistent as possible. As a project proceeds through programing and design, it is expected that the accuracy of the budget will improve. Using budgets from different stages introduces another variable into the statistical analysis. Therefore, it is recommended that multiple fields be set up in the accounting system to track the utility relocation budget at different stages of the project's life cycle. At a minimum, it is recommended that budgets be tracked at (1) programing, (2) beginning of design, and (3) prior to construction and after the majority of the utility agreements have been signed. Procedures for updating the budget at each of these stages should be established. For this to be useful, the programing, design, and construction budget should be stored in separate fields so that they are easily searchable.

4.5.2 Estimate Level of Detail

The level of detail for the estimate documentation used to prepare the utility agreements varies greatly. On one project (PIN 9413), there were utility agreements which:

- Did not have any backup (i.e., just a lump sum price),
- Were broken down by work classification (e.g., engineering, splicing, motor vehicle),
- Included unit price estimates for different construction items (e.g., 4-inch plastic main, directional bore for 4-inch pipe), and
- Estimates with cost for individual materials (e.g., fiberglass X-arms, X-arm pins).

Estimates with too little detail make it hard to verify the accuracy of the costs because there is not enough information to perform a thorough review. Estimates with too much detail also make it hard to verify the accuracy of the costs because UDOT personnel are unlikely to understand what individual materials are required to make up a construction component, such as a power pole.

Recommendations: Procedures should be established as to the appropriate level of detail for the estimates used to prepare utility relocation agreements. The level of detail should take into account the cost of the agreement. For example, all agreements over $25,000 require unit pricing; whereas documents under $25,000 could require less detailed documentation. Utility buy in is important for this recommendation to be successfully implemented. To encourage this buy in, it is recommended that training with the utilities be conducted to help them understand how UDOT, the contractor, and the utilities will benefit from the recommendations in this report.

4.5.3 Missing Power Sources

One of the most common overruns occurred on four projects (PINs 7867, 11547, 11679, and 13023) due to power sources being left out of the budget, which was a contributing factor for power utilities being the most likely utility to go over budget. There may be other occurrences where the power source was left out of the budget, but there were sufficient funds in the utility relocation budget to absorb the additional costs. One possible reason that so many power sources

are being missed is that, when budgeting for utility costs, utility relocation costs are being considered, but not power requirements because they simply do not come to mind.

Recommendations: To help ensure that the costs for power sources are included in the budget, it is recommended that power source costs be tracked separately from utility relocation costs. Doing this will require that UDOT consider and budget for power source requirements separately, reducing the likelihood that budgeting for power source requirements will be forgotten during the budgeting process. This will also help track one of the most common reasons for utility relocation cost overruns. To help implement this recommendation, training should be provided to the designers to help them understand how to budget for power source requirements and how this will benefit UDOT.

4.5.4 Unused or Replaced Utility Agreements

During the document review, there were seven projects (PINs 9691, 10004, 10709, 10785, 12241, 12311, and 13023) found where one or more of the utility agreements were unpaid. It is unclear if the work covered by these agreements was not performed or if the costs were missing. One project (PIN 9691) was also found where there were two utility agreements (one which has been paid and another which was not paid) that may be for the same work.

Recommendations: To improve the traceability of the utility agreement documentation, procedures for closing out and documenting unused and replaced utility agreements should be established. One way to do this is to establish a Utility Agreement Log that includes such information as project, date of agreement, utility, amount, status (e.g., negotiations, signed, complete, replaced, unused), and notes, which can be used to identify the agreement it was replaced by, or why it was unused. UDOT personnel will need to be trained in the use and benefits of the utility agreement log.

4.5.5 Utilities Not Included in Costs

In order to perform an unbiased analysis of the utility cost data, the accounting system must capture all of the utility costs, and only the utility cost, whether the work was performed by

the utility contractor, the general contractor, or UDOT. Missing or extraneous costs included in the data make it impossible to get an accurate measure of the utility costs as a percentage of the project's costs.

During the review of the documentation, five incidences where utility costs were performed by UDOT, the city, or the general contractor and were not captured in the utility cost data were found. They are as follows:

- PIN 8112, the utilities were handled by the city and included communication, gas, and power relocation. The project had a utility budget of $236,000 but no utility costs.
- PIN 9951, a power agreement includes $12,000 of work provided by UDOT.
- PIN 10709, a change order reduced a gas utility agreement by $24,685.58, due to the general contractor trenching and backfilling the gas line, with the costs being covered by the force account.
- PIN 10785, an agreement with a communications utility includes cost for work to be performed by the general contractor.
- PIN 13023, a change order references an invoice from a communications utility that was paid by the general contractor for an additional fiber box.

On one project (PIN 10709), the general contractor submitted an estimate for utility work by the gas company for $3,003.11. It is unclear if this work was ever performed.

On one project (PIN 13023), there was an agreement for landscaping repairs by the local city, which was included in the utility costs.

On one project (PIN 11408), there was a communication agreement that does not appear in the accounting data.

There were seven projects (PINs 9691, 10004, 10709, 10785, 12241, 12311, and 13023) where one or more of the utility agreements were unpaid. It is unclear if the work covered by these agreements was not performed or if the costs were missing.

Recommendations: Procedures should be established to ensure that all of the utility costs incurred by the general contractor are captured by the accounting system and correctly charged against the utility relocation budget. This may be done by establishing a utility contract with the general contractor for the utility work and having the general contractor bill the utility costs against the utility contract. Alternately, it may be done by an internal cost transfer (sometimes

referred to as an internal change order) from the project costs attributed to the general contractor to the utility relocation costs.

When UDOT incurs utility costs by paying an entity other than a utility, an internal cost transfer should be used to transfer UDOT's costs to the utility relocation budget and to document these costs. When local municipalities perform utility relocation work in exchange for UDOT performing work for the municipalities (such as upgrading water lines), the tradeoff should be documented using an internal cost transfer.

Finally, procedures for documenting the closing out of unused utility agreements and ensuring that all utility relocation costs have been captured should be established.

4.5.6 Missing Supporting Documentation

During the document review, there were a number of incidences where some or all of the supporting documentation was missing. For two projects (PIN 8129 and 12241) no documentation was available. On two projects (PINs 9951 and 10709), the total amount paid for utility relocation exceeded the amount documented by either the utility agreements or invoices; and it is unclear why these costs were incurred.

Recommendations: It is recommended that documentation supporting the utility relocation costs be reviewed when the utilities are closed out to ensure that all of the documents are readily located and available. The steps needed to close out the utility agreements could be documented on the Utility Agreement Log (See Section 4.5.4 Unused or Replaced Utility Agreements). In the event that the documents cannot be found, the attempt to find the missing agreements or invoices should be documented.

4.5.7 Utility Delay Documentation

During review of the documentation, four incidences were found where utility relocation caused delays (See Section 4.3 Noted Utility Delays). Discussion with UDOT personnel leads the authors to believe that the occurrence and impact of the utility relocation are not being adequately captured in the current documentation. This includes both direct delays (i.e., delays where work cannot proceed due to the utility work being incomplete) and indirect delays (i.e.,

loss in productivity on non-utility tasks because the non-utility tasks have to be sequenced around the utility relocation, which increases the time it takes to complete the non-utility tasks).

Recommendations: It is recommended that the procedures for documenting delays be reviewed, and where needed, improved. It is also recommended that UDOT personnel be trained on the importance of collecting accurate cost and delay data.

4.5.8 Difference between ePM and PDBS

During the document review, there were eight incidences on four projects (PIN 9691, 10709, 12292, and 12311) of payments showing up in ePM but not in PDBS. There was also one incidence (PIN 13592) where the original amount estimated for utilities was different from the ePM 505 estimate.

Recommendations: Where possible, entering data in two different systems should be avoided. Entering data twice can lead to differences in the data entered and data missing from one of the systems. When possible, a single system should be used to track project data. If possible, forms, such as the Utility Agreement Log, should be built into the accounting system. When this is not possible, data exchange between the systems should be explored. When it is not possible to combine systems, and it does occur, the data can be entered and maintained in multiple systems. To ensure that the data is properly recorded, tracked, and reported, the procedures covering who has administrative rights to enter data and create new reports need to be reviewed and modified as needed.

4.5.9 Costs by Utility

An analysis had to be performed to determine which of the utilities were over budget. Even then, it was not always clear. For example, one project (PIN 9951) had a utility budget of $67,151.00, utility agreement costs for $119,102.50 (excluding Utility Contract Overrun Funding Need, UCOFN, costs), and actual utility costs of $71,020.26. Only the communication agreement had a cost overrun (UCOFN) of $1,887.11, which is less than the amount ($8,913.26) the

project's utilities are over budget. As such, it is not possible to determine which of the utilities resulted in the project going over budget.

Recommendations: To make it easier to determine which utilities are over budget and to use performance metrics, it is recommended that the utility relocation budget line item should be set up so that (1) the total utility relocation costs and (2) the utility relocation costs by utility can be easily obtained from the system.

4.6 Summary

A number of issues were found during the review of the supporting documentation, many of which would adversely affect the quality of the utility cost data used in the statistical analysis. For an accurate statistical analysis to be performed, the quality of the underlying data needs to be improved.

5.0 FINAL RECOMMENDATIONS

The third and final objective of this project was to develop a recommendation on data tracking requirements that would be practical for UDOT to implement for measuring future program performance of utility relocations, provide implementation recommendations, and estimate the implementation costs. This chapter covers these issues.

5.1 Accounting Changes

A number of accounting changes were recommended in Section 4.5 Findings and Comments. These are summarized below:

- The account system should be set up to track utility budgets at (1) programing, (2) beginning of design, and (3) prior to construction and after the majority of the utility agreements have been signed; and procedures for preparing these budgets should be established.
- Procedures should be established as to the level of detail required from utilities for estimates used in preparing the utility agreements.
- Separate line items in the accounting system should be set up for (1) utility relocation and (2) providing power to traffic signals, lighting, and signage so that they may be tracked separately.
- A Utility Agreement Log should be set up to track project, date of agreement, utility, amount, status, close out status, and notes for each utility agreement.
- Procedures should be established to ensure that all of the utility costs incurred by the general contractor are captured by the accounting system and charged against the utility relocation budget.
- Procedures should be established for closing out the utilities, collecting all of the related documentation, and noting any missing documentation.
- Procedures for documenting delays should be reviewed, and where needed, improved.
- Where possible, entering data in two different systems should be avoided, either by combining systems or having the systems share or exchange data.

- The utility relocation budget line item should be set up so that (1) the total utility relocation costs and (2) the utility relocation costs by utility can be easily obtained from the system.

5.2 Utility Performance Metrics

It is recommended that performance metrics be established for both the individual projects and different utilities. There are two possible performance metrics: percent of budget spent and cost performance index (CPI). The percent of budget spent is calculated as follows:

$$Percent\ of\ Budget\ Spent = \frac{Actual\ Cost}{Budget\ Cost} \times 100$$

A value less than 100 would indicate that the project was completed under budget. A value of 100 would indicate that the project was completed on budget. And a value greater than 100 would indicate the project is over budget.

The CPI is a common metric for measuring the cost performance of construction projects. The CPI is calculated as follows:

$$CPI = \frac{Budgeted\ Cost\ of\ the\ Work\ Performed}{Actual\ Cost\ of\ the\ Work\ Performed}$$

A CPI of greater than one would indicate that the utility costs are under budget. A CPI equal to one would indicate that the utility costs are on budget. A CPI less than one would indicate that the utility costs are over budget.

Both of these metrics can be measured at any point during the project provided budgeted costs of individual utilities or utility components can be paired up with the actual costs. Tracking costs by utility would facilitate the use of these metrics.

Both going over budget and under budget are problematic. Going over budget means that additional funds need to be obtained to complete the project. Going under budget means that the unused funds that could have been used for additional scope or other projects are tied up on the project, which potentially results in other projects being delayed.

For either of these metrics to be used, the budgeted costs need to be developed and the actual costs need to be collected in a consistent manner. If the budgets are developed during different times in the projects' life cycle, it is going to be hard to make a fair comparison among projects.

To review the performance of the utility relocation as a whole, it is recommended that a comprehensive review of the utility cost and the associated documentation (as was done in this study) be done early in 2021.

5.3 Training

For the above accounting changes to be effective, UDOT personnel need to be properly trained in the procedures so that the procedures are consistently followed. It is also recommended that UDOT personnel be trained on the importance of collecting accurate cost and delay data. UDOT personnel are more likely to follow procedures if they understand why the procedures were established. Although this training can be done by UDOT personnel, it may be more cost effective for UDOT's employees to spend their time elsewhere.

5.4 Implementation

UDOT is currently upgrading their construction accounting system. Many of the above changes discussed in this report can be incorporated into this upgrade with minimal or no cost. In order for the changes in section 5.1 to occur, it is recommended that UDOT budgets include training.

5.5 Future Work

In order to assess the effectiveness of the recommendations in this report, it is recommended that a follow up study be performed early in 2021. The study should include the following tasks:

- Development of a sampling plan
- Data collection
- Data analysis
- Report

Appendix A – Utility Cost Overruns

This appendix contains additional information found regarding utility cost overruns. This information is separated by group. Groups C and D did not have any cost overruns.

Group A: Utilities and Over Budget

The following cost overruns were found for Group A:

- PIN 7109: Incurred an $8,315.83 cost overrun on a communication utility agreement. The source of the cost overrun was identified as follows: "There was an additional section of utilities from project station 836+00 to the end of the project that needed to be relocated. This section had not been called to be relocated in the original plans."
- PIN 7867: $720 was paid for a new power source. No other utility costs were incurred on the project.
- PIN 8581: An additional $2,820.59 was paid on an agreement with a power company. The source of this cost overrun was identified as follows: "The design was more expensive than the estimate. The project took longer than anticipated during the construction phase." This is supported by an increase in labor costs and external contract services.
- PIN 9413: An additional $139,420.44 was paid on a communication agreement. The source of this cost overrun was due to: (1) An increase in the engineering costs due to extensive coordination of utilities during the design phase. (2) A design change required a pedestal to be moved, which, due to poor coordination, was encased in concrete before it was moved, increasing the amount of work. (3) Repair and relocation of cables under 1000 West at 300 North. (4) Increased design costs due to utilities not being in the location they were thought to be. (5) Multiple repairs and relocation of a pedestal.
- PIN 9413: An additional $116,686.02 was paid on a power agreement. No reason for the cost overrun was found.
- PIN 9951: An additional $1,887.11 was paid on a communication agreement. No reason for the cost overrun was found.
- PIN 10004: An additional $18,617.19 was paid on a power agreement. No reason for the cost overrun was found.

- PIN 11547: An additional $1,884.88 was paid on a power agreement. No reason for the cost overrun was found.
- PIN 11547: An additional $3,176.11 was paid on a power agreement to provide power to a traffic signal.
- PIN 11679: $720 was paid for a new power source for school speed limit signs. No other utility costs were incurred on the project.
- PIN 13023: $5,237.97 was paid for a new power source for a traffic signal.
- PIN 13592: An additional $2,265.00 was paid for a transformer relocation.

Group B: Utilities and On or Under Budget

The following cost overrun was found for Group B:

- PIN 12181: A power utility agreement for $15,603.61 was increased to $16,304.73. Although this agreement exceeded its budget, the utilities on the project stayed within budget.

Appendix B – Details for Anomalies

This appendix contains additional information about the anomalies found during the document review. This information is separated by group. No anomalies were found for Group C.

Group A: Utilities and Over Budget

The following anomalies were found for Group A:

- PIN 9951: The sum of the expected costs to UDOT is $119,102.50, which exceeds the budget of $67,151.00.
- PIN 9951: $5,044.00 more was paid than the documentation shows was paid against the utility agreements.
- PIN 9951: A power agreement includes $12,000 of work provided by UDOT.
- PIN 13023: There is an agreement for $24,000 in landscape repairs included in the utility costs.
- PIN 13023: A change order (2-0004) references an invoice from a communications utility that was paid by the contractor for an additional fiber box. These costs do not appear in the utility costs.
- PIN 13592: The original amount estimated for utilities was $2,011, which is different from the ePM 505 estimate of $4,300. Using the original amount estimated for utilities, the utilities are over budget. Using the ePM 505 estimate, the utilities are under budget.

Group B: Utilities and On or Under Budget

The following anomalies were found for Group B:

- PIN 8112: This project had a utility budget of $236,000, but no utility costs. The documentation show that the utilities were handled by the city and include communication, gas, and power relocation.
- PIN 8129: This project had a utility budget of $32,654, but no utility costs. No utility documentation was found for this project.

- PIN 10709: The sum of the expected costs to UDOT ($889,829.48) from the utility agreements exceeded the budgeted cost of $597,970.00.
- PIN 10709: The total paid on the utility agreements was $520,446.73, which is less than the amount shown in the actual amount expended for utilities and 495 expenditures, both of which were $536,186.20. There are $15,739.47 of unaccounted costs.
- PIN 10709: The gas agreements included the following note: "The amount of original agreement #148264 was 126,862.95. A C.O. #2 reduced the amount by 24,685.58, due to [the general contractor] performing the work. This C.O. is under PIN 11966…" No agreements or invoices were found in ProjectWise or PDBS for PIN 11966. The following language was found in the Change Order 2 from PIN 11966: "This was work to install the…gas line in the roadway to get it done so that we can widen the roadway. [The gas utility] was not able to do their work in time that would coordinate well with our project. We discussed this with [the gas utility] and [the general contractor] and it was decided that [the general contractor] would do the trenching and backfill for the gas line ([the gas utility] would place the pipe) and we would cover the costs by force account and reduce our portion of the payment to [the gas utility] by this amount." The costs to the general contractor do not appear in the utility costs. Another problem is that PDBS and ProjectWise both show [the gas utility] Agreement #148264 for $217,360.00, not for $126,862.95, as stated above.
- PIN 10709: There were seven utility agreements with the power company, one of which was over budget by $1,104.28. Combined, the agreements were under budget by $5,983.72. Five of these agreements are shown as being paid, but the amounts are not in PDBS. One of the agreements was not paid and may have been replaced by one of the other agreements.
- PIN 10709: One of the agreements with the power utility identifies the work as "electrical service for the new signal at I-84 & Riverdale Rd," while Exhibit A identifies the work as "street lighting."
- PIN 10709: Two railroad agreements were not found. Their costs were $484.19 and $1,016.78.
- PIN 10709: The utility budget includes work on a water line for $6,450. No record of the agreement being paid was found.

- PIN 10709: There was an agreement with a local city in PDBS for $49,800.
- PIN 10709: One of the change orders for the general contractor may have included utility work by the gas company for $3,003.11.
- PIN 10785: The sum of the expected costs to UDOT ($7,139.50) from the utility agreements exceeded the budgeted cost of $2,994.00. The budget of $2,994.00 is within $1 of the actual cost from the only utility agreement paid.
- PIN 10785: Includes an agreement with a communications company for $972.50, but no record of the payment was found. If there was a payment made on this agreement, the project's utilities would be over budget.
- PIN 10785: An agreement with a communications utility for $6,167.00, includes cost for work to be performed by the general contractor of which UDOT would be responsible for $2,100. These costs do not appear in the utility costs. If these costs were incurred and paid elsewhere, the project would be over budget.
- PIN 11408: There is a communication utility agreement for $19,594.00 that does not show in the accounting data.
- PIN 12292: A power utility agreement is shown as being paid, but the amount is not in PDBS.

Group D: Preservation Projects

The following anomalies were found for Group D:

- PIN 9691: On April 27, 2015, a utility agreement with a communications company was established in the amount $13,800.00, which was paid in full. On September 3, 2015, a second agreement with the utility was established for $10,428.00, but no record was found of this agreement being paid. It is unclear if these agreements are for the same work.
- PIN 9691: A $2,100 payment shows in ePM, but not in PDBS.
- PIN 9691: Total expected costs to UDOT ($109,496.31) exceed the budgeted cost of $70,000.00. However, because one of the agreements did not have any costs, the project was under budget. If some of these costs were paid elsewhere, the project could be over budget.

- PIN 12241: No utility documentation was found for this project.
- PIN 12311: A $1,000 payment shows in ePM, but not in PDBS.